


We claim:

1. A method of generating holograms from photo-thermo- refractive (PTR) glasses,  
comprising the steps of:
- 5 exposing PTR glass with a UV light source or other source of ionizing radiation;  
exposing the UV exposed PTR glass with a high-power Visible light source;   
thermal treating the UV and Visible light exposed PTR glass; and  
restoring a hologram from the thermal treated PTR glass.
- 10 2. The method of claim 1, wherein the source of ionizing radiation is a UV light  
source.
- 3 The method of claim 2, wherein the step of exposing with UV light source  
includes a range of approximately 280 to approximately 350 nm.
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4. The method of claim 2, wherein the step of exposing with the UV light source is  
approximately 325nm.
5. The method of claim 2, wherein the step of exposing with Visible light source  
20 includes a range of approximately 450 to approximately 600 nm.
6. The method of claim 2, wherein the step of exposing with a Visible light source  
includes: approximately 532 nm.

7. The method of claim 1, wherein the step of exposing with a Visible light source includes: a high power source generating at approximately 10 megawatts/ cm<sup>2</sup> to approximately 100 gigawatts/ cm<sup>2</sup>.
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8. The method of claim 7, wherein the high power source generates at approximately 100 megawatts/ cm<sup>2</sup>.
9. The method of claim 7, wherein the high power source generates at approximately
- 10 10 gigawatts/ cm<sup>2</sup>.
10. The method of claim 1, wherein the step of generating a hologram includes the step of:
- generating a simple hologram having substantially planar surfaces of equal
- 15 refractive index.
11. The method of claim 1, wherein the step of generating a hologram includes the step of:
- generating a complex hologram having substantially curved surfaces of equal
- 20 refractive index.
12. The method of claim 1, wherein the step of thermal treating includes the step of:

thermal treating the PTR glass in a temperature region ranging from approximately 480 to approximately 580°C for a period of from a few minutes to several hours appropriate for phase transformation.

- 5    13.    A method of generating optical components from photo-thermo-refractive (PTR) glasses, comprising the steps of:

          exposing PTR glass with a UV light source;

          exposing the UV exposed PTR glass with a high-power Visible light source;

          thermal treating the UV and Visible light exposed PTR glass; and

- 10           generating an optical component from the thermal treated PTR glass.

14.    The method of claim 13, wherein the step of generating the optical component includes the step of:

          generating the optical component from one of a lens or multi-lens objective, a

- 15       combination of a prism or mirror with lenses, and a divergent/convergent beam splitter/combiner.

15.    An optical element comprising:

          a photo sensitive refractive(PTR) glass having photosensitivity to visible light

- 20       caused by UV exposure;

          means for exposing the UV exposed PTR glass to Visible light;

          means for thermal treating the UV and Visible light treated PTR glass; and

          means for using the PTR glass as a volume holographic optical element.

16. The optical element of claim 15, wherein the UV exposure includes a range of approximately 280 nm to approximately 350 nm.

5 17. The optical element of claim 16, wherein the UV exposure is approximately 325 nm.

18 The optical element of claim 15, wherein the Visible light exposure includes a range of approximately 450 nm to approximately 600 nm.

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19. The optical element of claim 18, wherein the Visible light exposure is approximately 532 nm.

20. The optical element of claim 15, wherein the thermal treatment means includes a  
15 range of approximately 480 to approximately 580°C for a period of from a few minutes to several hours appropriate for phase transformation.

21. The optical element of claim 15, wherein the holographic optical element includes: a simple hologram having substantially planar surfaces of equal refractive  
20 index.

22. The optical element of claim 15, wherein the holographic optical element includes: a complex hologram having substantially curved surfaces of equal refractive index.

5 23. A method of generating refractive optical elements from photo-thermo- refractive (PTR) glasses, comprising the steps of:

exposing PTR glass with a source of ionizing radiation;

exposing the UV exposed PTR glass with a high-power Visible light source;

thermal treating the UV and Visible light exposed PTR glass; and

10 restoring a hologram from the thermal treated PTR glass.

24 The method of claim 23 wherein the source of ionizing radiation is a UV light source.

15 25. The method of claim 23, wherein the refractive optical elements are lenses, waveguides, waveguide arrays and mux/demux devices.